Meta-evolution of Nature System – The Framework of History

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ABSTRACT

It is offered to investigate Nature from the position of its ***hierarchism****. There is introduced a concept of 'meta-evolution' – the procedure of levels/tiers overbuilding in a hierarchical system of the Universe in the course of its development which forms a hierarchical 'framework' ('skeleton') of lifeless, alive and 'human-artificial' nature subsystems, and 'benchmark points' of their historical development processes. For the meta-evolution study there are offered an informatics-cybernetic language and an appropriate formal toolkit – a mechanism of hierarchical adaptive search optimization (of the target criteria of energy character). And the latter is considered as the 'internal' (immanent) mechanism of organization of adaptive behaviour of the Nature system. The essence of work of this mechanism is presented graphically, with the help of a number of simplified evident diagrams. It is marked, that the 'arch (primary) factors' of 'social-technological' meta-evolution are: for bottom-paleolithic society – 'social proto-memory', top-paleolithic – 'proto-speech/proto-language', neolithic – 'proto-writing', industrial – 'proto-technology of the information duplicating', computer-based – 'proto-technology of computer equipment and electronic memory' etc. It is concluded that the process of development of the Universe as a whole seems to be* ***purposeful*** *(aimed at formation of 'itself' as a complete system of hierarchical search optimization, having the goal of permanent maximization of its efficiency).*

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Abbreviations:

bPALEO – bottom Paleolithic; tPALEO – top Paleolithic; COMP – computer-based; COSM – cosmic; INDU – industrial; MHASO – Mechanism of Hierarchical Adaptive Search Optimization; NEO – Neolithic.

INTRODUCTION

Making an attempt to actualize a comparative study of the Universe history from the moment of the so-called 'Big Bang' (which is considered to occur about 13.7 bill. years ago), of the Life history from the moment of the emergence of the Earth (about 4.6 bill. years ago), and, at last, – of the Humankind history (*i.e*. the last several millions years), one may ask a question: whether these historical flows, though differing so much, have anything in common? Whether it is possible, in particular, to distinguish among these three permanently developing subsystems of Nature (so different prima facie) some similar mechanisms forming their adaptive behaviour? And if 'yes' – then what formal descriptive language (if such a universal enough language generally exists) can be most adequate for these processes and mechanisms?

As it is believed, there exists and is described (see, *e. g.*, [Grinchenko 2004a]) an approach, within whose framework the answers to the first two of these questions will be affirmative. Admittedly, the approach is not applicable to the description of all vast variety of historical process in its complete volume, but only for modeling its 'framework'/ 'skeleton'/ 'basic structure'/ 'systems of benchmark' etc. As such a 'framework' the specified approach considers ***meta-evolution*** – the procedure of building up levels/tiers in the appropriate hierarchical system (in the process of its formation as such). Actually, this process is close to the set of meta-passages according to V. F. Turchin (1977). Such systems ('of high enough' complexity) are interpreted within the given context as systems, immanently including the mechanisms of hierarchical adaptive search optimization (MHASO) (of the appropriate target criteria of energy character) (Grinchenko 2004a).

Such an interpretation answers the third of the put above questions, as it means the application of the *informatics-cybernetic language* in its present advanced interpretation, with an appropriate

formal toolkit (taken in the field of technical cybernetics and that is terminologically precisely determined and well-advanced mathematically and which has practically shown the efficiency – see, *e. g*., [Rastrigin 1968, 1981]) to the description of the specified systems and their adaptive behavior. This in itself abruptly increases the opportunities of the historian-analyst giving a *verified* (although on a substantial material of a somewhat different area of application) and *really universal* tool for not only qualitative, but also quantitative analysis of the processes and systems investigated. In particular, it is possible to generate (to model) not only hierarchical search optimization patterns, but also to estimate (to calculate) the spatial-temporary characteristics:

- 52 structures consistently arising in the meta-evolution process of the *inanimate*,
- 13 similar to them, but much more complex structures, characteristic for the meta-evolution of *the animate*, and
- 22 even more complicated structures reflecting the basic stages of '*social-technological*' meta-evolution of Humankind, and moreover, only about 8 of them succeeded to be realized in the historical past and (partially) in present, and the formation and 'heyday' of the other 14 refers to the potentially possible future of the Humankind…

A brief account of the basic ideas and elements of the suggested approach is given below.

1. GENERAL STATEMENTS

For the Nature system we shall understand a set of its three basic manifestations – the subsystems of the *inanimate* nature, *animate* nature and '*human-artificial*' ('*The Second*') nature. Correspondingly the consecutive course of development processes of these subsystems can be naturally named an *inanimate* history, *animate* history and '*social-technological*' history.

The major characteristic (property) of Nature system as the *whole* (naturally, including the specified subsystems, its components) is ***hierarchy***. In other words, there is an urgent task to discriminate in the mentioned historical processes such aspects that correspond to the formation of the *new* hierarchical levels/tiers in the system in the course of it meta-evolution. It is expedient to

solve this task on the basis of the language of description of its 'generalized-adaptive' behavior (*i.e.* adaptation not only to changes of the environment external for the system, but also its internal environment) in the terms of the permanent work of MHASO (Grinchenko 2004a, 2004b).

Let's consider in detail the possible stages of Nature meta-evolution, using the given informatics-cybernetic language for its description. Here we take into account, that by virtue of *unity* of Nature (thesis which is not just only declarative!), many processes, at first sight characteristic only for this or that dimension of Nature, actually can have similar structure and also some parameters for the other dimensions. On the given basis it opens an opportunity of obtaining some new knowledge on this or that subsystem of Nature. But before it is necessary to explain at least briefly and concisely that the above-mentioned MHASO represents itself.

The toolkit of informatico-cybernetic modeling of Nature system, as it seems, allows to realize the following basic properties of Nature system:

- *activity* (expressing itself as an 'individuality');
- *expansivity* (the aspiration to its own growinging extension in space);
- *structurization* up to *hierarchism* (the emergence of subsystems, each one delimiting its own internal environment from its surroundings);
- *generalized adaptability* (the aspiration to a harmonicity, *i.e.* to the coordination of internal interests of a subsystem with the needs of its external environment).

From the mathematical point of view this toolkit is expressed through iterative correlations which one can acquire, *e. g.*, in (Grinchenko 2004a). But in the present paper, for the sake of visualization and taking into account interests of 'a more classical' reader, it is better to present it graphically with the help of a number of simple and vivid diagrams.

The elementary variant of such a diagram is given in a Fig. 1a. It is just the two parameters that point to the fact that this *is a hierarchical contour* of search optimization:

a) the characteristic time t of the change of the search activity A_t, shown by the elements of N-th tier in the system hierarchy, is

much less than the characteristic time T of the reaction to this activity – of the change of target criterion K_T, set by the corresponding element of the (N+1)-th tier: $t << T$;

б) the characteristic size l of the elements of the N-th tier in the system hierarchy is **much less** than the characteristic size L of the corresponding element of the (N+1)-th tier: l <<L.

As an element of the (N+1)-th tier *consists of* the elements of the N-th tier, thus forming an elementary hierarchical structure, so the correlations mentioned are obvious enough.

Avoiding details, the essence of functioning of the pattern of Fig. 1a, generally speaking, comes to the following. At each temporary cycle of the optimization process in the hierarchical contour all the elements of the N-th tier '*behave*' actively, *i.e.* they generate a certain vector ('a cluster') of search influences on some element of the (N+1)-th tier (*i.e*. on the whole set of the similar elements and including the element itself). The last one reacts with a quite determined *inertance* (*i.e*. to some *sequence* of temporary steps of the elements of the N^{th} tier), generating a respective alteration of its target criterion. Thus, it gives out a signal of the 'comfort'-'discomfort' kind (of the energy character) for all its constituent elements. And if the signal is 'comfort' – then the previous activity of each of the elements of the N^{th} tier can be continued 'in the same strain', there is not any special managing 'from above' influence on that activity. But if the signal is 'discomfort' – it is just the influence of the kind that emerges *initiating* a change in a direction and intensity of the search activity (but *not specifying* them!) of each element of the N-th tier.

This elementary algorithm of search optimization is widely known and is applied successfully in technical cybernetics where it is named 'a random search with punishment by randomness' (Rastrigin 1968, 1981). Certainly, in Nature system similar algorithms are a little bit more difficult (that is already evident from the simplified diagram in Fig. 1b), but their *essence* is still close to the described one.

I would add that the notion **'much less',** used four-five paragraphs earlier, can be specified: for the diagram in Fig. 1a it makes about 3,5 thousand times. That is *inertance* of the reaction of the element of the (N+1)-th tier on search 'hunting' of its constituent elements of the N-th tier is rather significant. And it testifies to the lowest efficiency of the considered variant of the search optimiza-

tion mechanism.

It is essential the similar mechanism presented in Fig. 1b has a better efficiency (for which the notion **'much less'** makes about 15 times). For the sake of greater specification the diagram of the fragment of the MHASO of an animate nature is presented here and also there are given the characteristic sizes and characteristic times of change of the elements composing the given hierarchical optimization contour.

By the way I would like to note, that the calculated spatial and temporary characteristics of the MHASO should be considered only as *ideal* estimations specifying some basic points in the specified spaces of variables, and not as the requirements to their *exact* values in reality. This follows from the interpretation of the characteristics as parameters of the appropriate hierarchical contours of the MHASO that does not impose too strong restrictions on their values and does not require their high accuracy. The hierarchical contour of search optimization will work even at a significant deviation (of course, in 'reasonable' limits) of these parameters from the 'ideal' calculated ones.

The practice of technical cybernetics shows, that the ratio of characteristic times of two hierarchically adjacent search optimization processes should make approximately 1 to 10÷20. The application for this ratio specification of the results received by A. V. Jirmunskiy and V. I. Kusmin (1982) at the decision by more local (but close on sense) task of study of critical levels of biological systems development, allows to accept the given ratio equal $e^e = 15{,}15426...$

Sending the reader to the detailed description of informatics-cybernetic diagrams functioning, these and similar to them, to the monography (Grinchenko 2004a), I shall note only, that *methodologically* the majority of results of the subsequent sections of the present article are received with the help of various modifications and combination of such circuits.

2. ABOUT THE META-EVOLUTION OF LIFELESS NATURE

As it can be pictured, the beginning of lifeless meta-evolution coincides with the moment of the beginnings of the Universe. This

moment, according to modern representations, is associated with the moment of hypothetical 'Big Bang' (about 13,7 bill. years ago). In the article (Grinchenko 2004c) the hypothesis is put forward and proved that the lifeless meta-evolution occurs *with a deceleration*: each new *ideal* 'top'-tier in hierarchy requires approximately to a degree more time (more precisely, ~15,15426 ….) for the formation, than its predecessor has spent on the given process. Thus '*plankteon*' is in the role of the most 'bottom' tier in the lifeless hierarchy – the low limit cell of the Universe space (*i.e. fundamental, or M. Plank's*, length $l_f = 0{,}16 \cdot 10^{-32}$ cm), which was generated during the *fundamental, or M. Plank's*, time $T_f = l_f / c = 0{,}54 \cdot 10^{-43}$ sec. (where c – the light speed) after the Big Bang moment. According to the given hypothesis both the moments of the achievement of the values of levels/tiers in hierarchy of the Universe (an extending – at the light speed! – 'ideal' structure) selected this way, and these values themselves are easily calculated (see Table 1). It allows to outline the contours of that 'historical arena', where later on there will be performed 'the scenarios' of the emergence, development (and, perhaps, of the destruction) possible in the given Universe subsystems of animate and, in its turn, of social-technological nature.

Table 1. The theoretically designed spatial-temporary characteristics of the inanimate nature's hierarchical system

№ tier	№ ps. tier ☼	The characteristic linear size of a tier in hierarchy (calculated)	The names of the empirically observable representatives of the given hierarchical level/tier and their typical sizes	Meta-evolution's characteristic time of a tier in hierarchy (calculated)
1	2	3	4	5
0	**0**	**0.16 10^{-32} cm** l_f - Fundamental (M. Plank's) length	**Fundamental (primary) cell of space-time of the Universe, or 'plankteon' ***	**0.54 10^{-43} sec.** Fundamental time $T_f = l_f / c$
1		0.24 10^{-31} cm	Small-size **'postplankteons-1' ***	0.82 10^{-42} sec.
2		0.37 10^{-30} cm	Middle-size **'postplankteons-1' ***	0.12 10^{-40} sec.
3	**1**	**0.56 10^{-29} cm**	Full-size **'postplankteons-1' ***	**0.19 10^{-39} sec.**

4		0.85 10^{-28} cm	Small-size **'postplankteons-2' ***	0.28 10^{-38} sec.
5		0.13 10^{-26} cm	Middle-size **'postplankteons-2' ***	0.43 10^{-37} sec.
6	**2**	**0.19 10^{-25} cm**	Full-size **'postplankteons-2' ***	**0.65 10^{-36} sec.**

Продолжение табл.

1	2	3	4	5
7		0.30 10^{-24} cm	Small-size **'postplankteons-3' ***	0.99 10^{-35} sec.
8		0.45 10^{-23} cm	Middle-size **'postplankteons-3' ***	0.15 10^{-33} sec.
9	**3**	**0.68 10^{-22} cm**	Full-size **'postplankteons-3' ***	**0.23 10^{-32} sec.**
10		0.10 10^{-20} cm	Small-size **'postplankteons-4' ***	0.34 10^{-31} sec.
11		0.16 10^{-19} cm	Middle-size **'postplankteons-4' ***	0.52 10^{-30} sec.
12	**4**	**0.24 10^{-18} cm**	Full-size **'postplankteons-4' ***	**0.79 10^{-29} sec.**
13		0.36 10^{-17} cm	Small-size **'postplankteons-5' ***	0.12 10^{-27} sec.
14		0.54 10^{-16} cm	Middle-size **'postplankteons-5' ***	0.18 10^{-26} sec.
15	**5**	**0.82 10^{-15} cm**	Full-size **'postplankteons-5' ***	**0.27 10^{-25} sec.**
16		0.12 10^{-13} cm	Small-size nucleuses of atoms	0.42 10^{-24} sec.
17		0.19 10^{-12} cm	Middle-size nucleuses of atoms	0.63 10^{-23} sec.
18	**6**	**0.29 10^{-11} cm**	**Spheres of atom's nucleuses** (~10^{-12} -10^{-13} cm)	**0.96 10^{-22} sec.**
19		0.43 10^{-10} cm	Small-size atoms	0.14 10^{-20} sec.
20		0.66 10^{-9} cm	Middle-size atoms	0.22 10^{-19} sec.
21	**7**	**0.999 10^{-8} cm (1 A)**	**Spheres of atoms** (N. Bohr's radius of hydrogen atom 0.529 10^{-8} cm)	**0.33 10^{-18} sec.**
22		0.15 10^{-6} cm	(bioanalogue – organic molecules)	0.50 10^{-17} sec.
23		0.23 10^{-5} cm	(bioanalogue – macromolecules)	0.76 10^{-16} sec.
24	**8**	**0.35 10^{-4} cm**	**Spheres of 'dusts' *** (bioanalogue – prokaryote units)	**0.12 10^{-14} sec.**
25		0.53 10^{-3} cm	(bioanalogue – sub-compartments of cell)	0.17 10^{-13} sec.
26		0.80 10^{-2} cm	(bioanalogue – compartments of cell)	0.27 10^{-12} sec.
27	**9**	**0.12 10^{0} cm**	**Spheres of 'kerns' *** (bioanalogue – eukaryote cells)	**0.40 10^{-11} sec.**
28		0.18 10^{1} cm	(bioanalogue – tissues)	0.61 10^{-10} sec.

29		0.28 10^2 cm	(bioanalogue – organs)	0.93 10^{-9} sec.
30	**10**	**0.42 10^3 cm (4.2 м)**	**Spheres of 'boulders' *** (bio-analogue – pluricellular organisms)	**0.14 10^{-7} sec.**
31		0.64 10^4 cm (64 m)	(bioanalogue – populations)	0.21 10^{-6} sec.

Продолжение табл.

1	2	3	4	5
32		0.97 10^5 cm (970 m)	(bioanalogue – parcels)	0.32 10^{-5} sec.
33	**11**	**0.15 10^7 cm (15 km)**	**Spheres of 'mille-planets' *** (bioanalogue – biogeocenosis)	**0.49 10^{-4} sec.**
34		0.22 10^8 cm (222 km)	(bioanalogue – biomes)	0.7410^{-3} sec.
35		0.34 10^9 cm (3370 km)	(bioanalogue – natural zones)	0.11 10^{-1} sec.
36	**12**	**0.51 10^{10} cm (51 Mm)**	**Spheres of planets** (bioanalogue – Biospheres)	**0.17 10^0 sec.**
37		0.77 10^{11} cm (770 Mm)	(bioanalogue – complex 'Earth-Moon and near satellites')	0.26 10^1 sec.
38		0.12 10^{13} cm (11.7 Gm)	(bioanalogue – complex 'Earth-distant satellites')	0.39 10^2 sec.
39	**13**	**0.18 10^{14} cm (177 Gm = = 1.18 a.u.)**	**Spheres of planet groups** (bio-analogue – Sphere of terrestrial group planets)	**0.59 10^3 sec. (10 minutes)**
40		0.27 10^{15} cm (18 a.u.)	Complex 'Star-planets'	0.90 10^4 sec. (2.5 hours)
41		0.41 10^{16} cm (270 a.u.)	Complex 'Star-distant not planetary formations'	0.14 10^6 sec. (1.57 day)
42	**14**	**0.62 10^{17} cm (4130 a.u.)**	**Star systems**	**0.21 10^7 sec. (24 days)**
43		0.94 10^{18} cm (0.3 parsec)	Large globules	0.31 10^8 sec. (0.99 year)
44		0.14 10^{20} cm (4.6 parsec)	Clusters of stars	0.47 10^9 sec. (15 years)
45	**15**	**0.21 10^{21} cm (70 parsec)**	**Associations of stars**	**0.72 10^{10} sec. (227 years)**
46		0.32 10^{22} cm (1.06 kiloparsec)	Star complexes	0.11 10^{12} sec. (3.4 Thousand years)
47		0.49 10^{23} cm (16 kiloparsec)	Dwarf galaxies	0.16 10^{13} sec. (52.2 Thou-sand years)
48	**16**	**0.75 10^{24} cm**	**Galaxies** (seen part ~ 30-40 kilo-	**0.25 10^{14}sec.**

		(242 kiloparsec)	parsec)	**(790 Thou-sand years)**
49		0.11 10^{26} cm (3.67 megaparsec)	Groups of galaxies	0.38 10^{15} sec. (12 Millions years)

Окончание табл.

1	2	3	4	5
50		0.17 10^{27} cm (55.7 megaparsec)	Cluster of galaxies	0.57 10^{16} sec. (182 Millions years)
51	**17**	**0.26 10^{28} cm (844 megaparsec = 2.75 Billions of light-year)**	**Superclusters of galaxies**	**0.87 10^{17} sec. (2.75 Billions years)**
–	–	~4,2 gigaparsec, or ~13,7 Billions of light-year	The current moment: Meta-galaxy	~13,7 Billions years
52		0.39 10^{29} cm (12.8 gigaparsec = 42 Billions of light-year)	? Sub-compartments of post-meta-galaxies *	0.13 10^{19} sec. (42 Billions years)
53		0.59 10^{30} cm (194 gigaparsec = = 632 Billions of light-year)	? Compartments of post-meta-galaxies *	0.20 10^{20} sec. (632 Billions years)
54	**18**	**0.90 10^{31} cm (2.94 teraparsec = 9.58 trillions of light-year)**	**? Post-meta-galaxies ***	**0.30 10^{21} sec. (9.58 Trillion years)**
…				
The notes: ☼ – № of a pseudo-tier; * – names operative, preliminary				

For comparison with existing conceptions of the chronology of the Universe I shall adduce the table from the article ‘Big Bang’ in the Astronomical dictionary (San'ko 2001), placed at the Space Research Institute (IKI RAS) site:

Table 2. The approximate chronology of the events, which have followed the zero moment of time.

Time from the beginning of the Big Bang	Temperature (Kelvin scale)	Event	Consequences
1	2	3	4

0–5*10^{-44} sec.	1,3*10^{32}	no any authentic items of information	
5*10^{-44}–10^{-36} sec.	1,3* 10^{32}–10^{28}	The beginning of action of the known physical laws, the era of inflationary expansion	Expansion of the Universe proceeding until now

Окончание табл.

1	2	3	4
10^{-36}–10^{-4} sec.	10^{28}–10^{12}	The era of intermediate bosons, and then – era of adorns, existence free quarks	
10^{-4}–1–3 sec.	10^{12}–10^{10}	Emergence of particles and antiparticles from free quarks, and also their annihilation, emergence of a transparency of substance for neutrino	Emergence of barion's asymmetry, Emergence of neutrino relict radiation
1–3–100–120 sec.	10^{10}–10^{9}	Passing of nuclear reactions of helium nucleuses synthesis and some other easy chemical elements	Determination of the primary ratio of chemical elements
Between 300 thousand – 1 million years	3000–4500	The ending of recombination era	Emergence of relict radiation and neutral gas
1 million – 1 billion years	4500–10	The development of gravitational heterogeneities of gas	Formation of stars and galaxies

The comparative analysis of these tables allows formulating the following conclusions:

A) It is evident that the second table (together with in the majority of other references – see, *e. g.,* [Fizika 1983; Vasilev 1996]) lacks spatial characteristics of the enumerated there basic (from their authors' points of view) events of the Universe chronology after the Big Bang. They are adduced sometimes (*e. g*., [Penionzhkevich 1998], Fig. 1), but there arises the problem of conformity of the interpretation of spatial and temporary scales. Actually, the addition of estimations of the linear sizes – and, consequently, of the scale – in the appropriate analysis is rather productive, as it immediately allows to account many additional characteristics. Thus the information basis necessary for understanding of properties of Nature which it exhibits at all meta-phases of its meta-evolution, if supplemented by its 'ideal' characteristics (based on the suggested informatics-cybernetic approach), can be rather essentially extended.

B) Besides it should be mentioned that temporary characteristics of Table 2 could be by no means correlated with all possible 'cellules' of Table 1. But for those cases, when it can be a success, the fact is obvious, that in all such cases the times of events from Table 2 are not less than the corresponding times from Table 1 (if to treat one of tiers 'postplankteon-1' or 'postplankteon-2' as the tier of intermediate bosons). That is the 'ideal' tiers as such in the beginning have time to be generated, and only then these or those material formations start to originate on them.

It would be bulky to present the complete Table 1 in the form of diagrams. So I shall limit only with diagrams of formation of the very first (Fig. 2a), and also current (Fig. 2b) hierarchical contours of optimization the lifeless. As it is evident from Table 1 the current moment corresponds to the meta-phase of formation of the 52^{nd} tier in the hierarchy of the lifeless, which began about 11 bill. years ago also will finish in ~28,3 bill. years.

It should be noted that having been generated once, the elements of this or that tier of the hierarchical search optimization system start 'to behave', to manifest in their characteristic rate (and in the characteristic sizes) the appropriate forms of adaptive behaviour. And the characteristic intervals of these processes are much more than the intervals needed for the first time formation of the given tier. So, for the lifeless hierarchy the consideration of this empirical fact corresponds to the shift of the time scale from Table 1 ten positions downwards. From this there follows a rather unexpected conclusion that not all the tiers in the hierarchy of the lifeless nature, whose *ideal structure* has been quite formed by the present time, were in time to start *manifesting* their adaptive properties.

Already starting from the tier num. 40 'Complex "star-planets"' and the above characteristic intervals of the change of the appropriate processes exceed the current time of the Universe existence (Fig. 2b). And it means, that the corresponding hierarchical contours of the search optimization do *not closed – i.e.* as if they are absent at all (for now!).

There is an impression, that it was exactly this 'dead end' in the development of the lifeless which is the trigger (or the cause?) of the *first* change of the Universe strategy in its development.

3. ON THE META-EVOLUTION OF THE ANIMATE NATURE

Judging by the only (so far) reliable example, the animate could have emerged – starting its *own meta-evolution* – during the 52nd meta-step of the lifeless meta-evolution. Are these events connected? As it was mentioned above, the duration of this meta-step makes more than 39 bill. years. The fact, that in the Earth environment the animate started to develop only ~6,35 bill. years after the beginning of the meta-step (*i.e.* when 16 % of its complete duration has already – or yet –passed), allows to assume, that these events are not correlated *directly*. The concrete moment of the beginning of life in this or that zone of the Universe is most likely determined by the external reasons: by the presence in some space of a sufficient variety of chemical elements at the temperatures allowing the appropriate chemical reactions to proceed, and their results – not to decompose too quickly. This could have quite occurred during the above-mentioned 39 bill. years of the complete duration of the52nd meta-step of the lifeless meta-evolution– and still can happen in the future – in various zones of Space. Thus, it by no means contradicts the idea about the plurality of the 'alive' Worlds (about 'habitable' we shall speak later, in section 4).

So, basing on the empirical data, the beginning of the meta-evolution process of the animate nature on the Earth is defined about 4,6 bill. years ago. Basing on the same data (often determined with a wide range of estimations), in a geological-biological history of the Earth there are distinguished 5 large-scale periods – eons. Here are referred the already finished Katarchaean (Hadean), Archaean, bottom Proterozoic, top Proterozoic and current Phanerozoic. It is interesting, that the comparative analysis of duration of the finished eons (of the estimations given in [Alejnikov 1987; Biologija 1999; Milanovskij 2001; Aplonov 2001] etc.) has given an unexpected result: 1,01±0,16 bill. years, *i.e.* to a high accuracy they can be considered equal. (As the duration of Phanerozoe is usually defined today as 0,57±0,02 bill. years, it is quite possible to assume, that there are approximately 0,44 bill. years left before its end)

The comparison of the specified empirically selected periods of the development of the animate nature with theoretical (informati-

cal-cybernetic) representation of the formation of new hierarchical tiers allows to draw the following parallels between the *animate nature meta-evolution* and *eons*:

From atoms up to 'elementon' (procaryote units) = Katarchaean (Hadean),

From 'elementon' (procaryote units) up to eukaryote cells = Archaean,

From eukaryote cells up to pluricellular organism = bottom Proterozoic,

From pluricellular organism up to biogeocenosis = top Proterozoic,

From biogeocenosis up to Biogeosphere (its current condition and further) = Phanerozoe (Grinchenko 2004a).

In Fig. 3 (1–13) the simplified circuits of basic meta-steps of the animate nature meta-evolution are presented. They demonstrate, that the most characteristic difference of the animate from the lifeless is the emergence of the mechanism of reproduction (and account) of the past experience about the process of hierarchical search optimization in system (for detail see *ibid*.) on each tier in the hierarchy of the *animate system memory.*

The direct consequence of the existence of the animate system memory – and its absence of the lifeless! – is the fact, that the hierarchy of the lifeless at each moment of meta-evolution – including the present one – is presented to us in the only sample. The smaller tiers included in it, are *equivalent* from the positions of the higher tiers and the system on the whole! On the contrary, the hierarchical structures formed at various meta-steps of the animate meta-evolution, exist (if were in time to arise) in parallel and simultaneously! In particular, procaryotes and pluricellular organisms adjoin quite successful (being enclosed one into another or autonomous), as well as single-celled eukaryotes and biogeocenoses, etc.

As the formation of every triad of tiers in the animate hierarchy took about 1 bill. years, then, consequently, for one tier it took about 337 millions years. If the introduced parallelism is adequate to reality, then in the biological history of the Earth there should take place some significant enough, and maybe revolutionary events, the time intervals between which are proximate to one third of a billion years. And indeed: the existing empirical estimation of the duration of Paleozoic era, whose beginning coincides with the

beginning of Phanerozoe, and the end is defined about 235±0,01 millions years ago (*i.e.* 570 millions years – 235 millions years = 335 millions years), is rather close to the calculated estimation 337 millions years. In its turn the following event of the same rank of importance should take place (theoretically) approximately *in* 103 million years. And it means, that the event connected with the moment of change of the Age of Reptiles by the Age of Mammals has a lower rank etc.

As it is evident from comparison of Figures 2 and 3, the condition of coordination of the spatial-temporary characteristics of the inanimate and animate (actually the condition of maintenance of the possibility itself of the emergence of life!) is kept. From here it follows, that the animate can meta-evolve *as a whole*, saving its adaptive properties, only up to the tier 'The Sphere of terrestrial group planets' (inclusive). Here again comes an impression that the given 'dead end' in the development of the animate is the trigger (or the cause?) of the *second* change of the Universe further development strategy.

4. ON THE META-EVOLUTION OF 'HUMAN-ARTIFICIAL' NATURE

For the meta-evolution of a 'human-artificial' Nature, again judging by the only available example, the beginning cannot be specified because of an ambiguity what is already possible to consider as 'human-artificial' Nature, and what can not be considered as such. The selected events in such a range: the *cephalization* of the vertebrata (about 428–441 million years ago); the emergence of *prehominid* (superfamily Hominoidea), possessing the rudiments of *biosocial relations* (about 28.2–29.1 million years ago); the emergence of *proto-human* Homo erectus, connected with an 'avalanche' increase of its neocortex and the emergence of '*social memory*' (about 1.86–1.92 million years ago); the emergence of the second signal system for Homo erectus, *i.e.* of the *proto-speech* and *proto-language* connected with it, thus transforming him in Homo sapience about 123–127 thousand years ago; the emergence (about 8.10–8.35 thousand years ago) of *proto-writing*; etc. Even if to consider the emergence of Homo sapience proper as such a 'beginning', any way it is in no way possible to ignore stages previous to

it. I repeat that all the above-mentioned calculated dates should be considered as *ideal*, or directing.

Social-technological meta-evolution, or the process of formation by the Human of the Second nature, keeping to the main features of the *animate nature* meta-evolution, nevertheless differs from the latter in a number of features. So, the procedure of consecutive growth of hierarchy of the *animate nature* system in 'triads' (whose elements differ in the increasing level of complexity) – in the hierarchy of social-technological system of the Humankind with consistently growing complexity is replaced by the formation of more and more multilevel structures (4, 5, 6 etc.) starting in shorter and shorter periods of time. The latter reflects the tendency of 'spatial' expansion of Humankind *as a complete system* first on the Earth, and then and in Space, with parallel development of higher and higher (up to nuclear and sub-nuclear) technologies of the Universe cognition and supplementing it by new artificial ('human-made') objects. The calculations I carried out show (Grinchenko 2001, 2002) that at *the beginning of the 80s of the 20th century* the Humankind has *already* entered the phase of its 'mature' development, fundamentally different in many properties and complexity of organization from the previous (but to a certain extent continuing to exist 'in parallel') phases of 'childhood', 'adolescence' and 'youth'.

On rather simplified diagrams the course of social-technological meta-evolution of Humankind can be presented rather vividly, but still one should bear in mind that on the whole the Humankind meta-evolves quite *continuously*, and the presented diagrams corresponding to certain critical moments in its development, seems *discrete*. And only a much more detailed analysis (for which the allowed volume of the present article is obviously insufficient) allows to catch and specify those peculiarities of the given process, which demonstrate that the mentioned discreteness is only an episode in the continuous course of the Universe meta-evolution.

Pre-humankind-1. About 28.2–29.1 million years ago (the calculated 'ideal' data) in separate 'troops-1' of *pre-hominids* (of superfamily *Hominoidea*), compactly occupying territories with linear sizes ranging from several decameters up to several kilometers, there

started to appear the rudiments of ***pre-social relationsips***. And among other these pre-hominids showed ability to involve *actively* in the 'orbit' of the ordinary life and work those surrounding them objects of the inanimate and/or animate nature whose sizes could be changed (corrected, rectified) to several *decimeters* (see Fig. 4a). It is convenient to name objects of this sort ***pre-adaptations***, the examples of the latter – trunks and branches of trees, animals' skin, bones and horns, pieces of relatively soft stone and firm clay, etc.

In its turn, the huge values of inertances of adaptive behaviour are typical for the pre-hominid troop-1: as temporary reaction of band-1 *as a whole* on active search behaviour (actually, the *innovations*) of its individual members, and the procedure of fixation of an innovation assimilated by band-1 in its historical ('system') memory (in both cases the ratio of characteristic times is about 1 to 3400). In absolute figures the latter means that the 'commonly adopted' innovation can be preserved by generations of pre-hominid for ~3400 years running, thus having turned in real dogma. And even if its initial 'success' in due course is questioned – the conservatism of band-1 is so high that the chances of even insignificant updating of such a rather archaic 'innovation' seem to be rather low. Nature uses the same way out from this 'human-artificial' meta-evolutionary dead end as in the cases of the animate nature meta-evolution: sporadic appearance in local spatial zones of band-1 of hierarchical compositions which have the implication as 'sub-contours' of hierarchical optimization. Namely: the elementary bi-level compositions '*pre-hominids–pre-family*', '*pre-family–pre-kin*' and '*pre-kin–pre-tribe*', and also their three-level and tetra-level combinations, which can already show a little bit larger efficiency of the adaptive behaviour though in not a complete spatial volume of initial band-1 (details see in [Grinchenko 2004a]).

Within the framework of the suggested conception it is important that the characteristic size of *accuracy* of correction of the *pre-adaptations* generated by Nature itself coincides with the characteristic size of an *organ* of pluricellular organism, or actually of *pre-hominid* proper. Therefore taking into account the total significance of the above-mentioned properties the considered 'band-1' can be called a *'Populatio-parcello-biogeocenoso-organs society'* (for the

explanation of the terminology used here and below see in [*ibid*]) where the basic structure of **Pre-Humankind-1** is presented.

(It is possible that something of that sort had been 'invented' earlier or later by the representatives of other faunistic groups on the Earth, but these 'inventions' did not endure simply because their authors could not achieve a *continuity* of the domination in an appropriate biogeocenosis, and were replaced by more aggressive, but less talented competitors for whom the development of somebody else's 'inventions' appeared simply 'beyond their mind'. However, the opposite variants of assimilation of this heritage by the newcomers are also possible).

Proto-Humankind-2. About 1.86–1.92 million years ago (the calculated 'ideal' data) in separate *bPALEO-kins-2* (bPALEO – bottom paleolithic) (consisting of *bPALEO-families-1* of *bPALEO-proto-humans* Homo erectus), compactly living on territories with the linear sizes ranging from several hectometers up to several kilometers there started to appear the rudiments of ***social proto-memory.*** The encyclopedia of UNESCO 'History of Mankind' and other sources estimate the time of the emergence of Homo erectus as about 1,8–2 million years ago (Mohen 2003: 21).

And besides these bPALEO-proto-humans showed the ability to involve in the 'orbit' of the ordinary life and activity those surrounding them objects of inanimate and/or animate nature whose sizes could be changed (corrected, rectified) with accuracy already up to several *millimeters* (see Fig. 4b). It is convenient to name such objects as ***proto-equipment***, their examples – for the moment rather rough toolkit of the bottom paleolith, which nevertheless, was capable to provide security and improvement of dwellings, greater convenience and functionality of clothes, footwear, home utensils and other needs.

In its turn, for bPALEO-kin-2 are typical high values of inertia of adaptive behaviour – temporary reactions – both of bPALEO-families-1 to the 'innovations' of their individual members, and of bPALEO-kin-2 as a whole to the 'innovations' of constituent bPALEO-families-1. The values are rather high for the inertias of procedures of fixation of the perceived innovations in historical ('system') memory – both by bPALEO-proto-humans, and bPA-

LEO-families-1 (in both these cases the ratio of characteristic times is about 1 to 59). In absolute figures the last means, that the 'commonly adapted' innovation can be preserved by generations of bPALEO-proto-humans for ~58,4 years running. But if there is not any 'reinforcement' of the given system memory after the expiration of this time, it will mean 'forgetting' – the elimination of the specified information from the system memory of bPALEO-kin-2.

Within the framework of the suggested concept it is important that the characteristic size of the accuracy of correction of proto-equipment formed by Nature itself coincides with the characteristic size of pluricellular organism *tissues* (or actually of bPALEO-proto-human). Therefore taking into account the total significance of the above-mentioned properties the considered bPALEO-kin-2 it could be named a '*Parcello-biogeocenoso-tissues society*' representing the basic structure of **Proto-Humankind-2**.

Proto-Humankind-3 = Meso-Humankind-0. Let's mean by the 'tPALEO' abbreviation not only 'top Paleolithic' proper, but also near to this period the middle Paleolithic and Mesolithic periods. Then, it is possible to claim that about 123–127 thousand years ago (the calculated 'ideal' data) in separate *tPALEO-tribes-3* (consisting correspondingly from *tPALEO-kins-2 – tPALEO-families-1 – tPALEO-humans*), compactly living on territories with the linear sizes up to several kilometers there started to arise the second signal system, *i. e.* tPALEO-humans' ***proto-speech*** and connected with it ***proto-language***. Thus, Homo erectus started the transformation into Homo sapience.

In my opinion, nobody disputes that the Man and Speech – are non-separable concepts. The dates of realization of this fact are estimated on different grounds in the range of 200–130–60–40 thousand years ago. The encyclopedia 'History of Mankind' does not give an estimation of speech and language rise date but specifies, that Homo sapience appeared between 130 and 100 thousand years ago (Klima 2003: 206). It is evident the calculated 123–127 thousand years ago are quite fitting this range.

Besides, tPALEO-humans showed ability to involve in the 'orbit' of their ordinary life and activity those surrounding them objects of inanimate and/or animate nature whose sizes could be changed (corrected, rectified) with accuracy already up to several *hundreds micrometers* (see Fig. 4c). It is convenient to name such

objects as ***tools***, their examples are high-accuracy toolkit of top paleolith, instruments of work, protection and attack, etc. As result of their use – there was an essential increase of tPALEO-tribes-3 life quality.

It is rather important, that for tPALEO-phratries-3 are typical those values of adaptive behaviour inertia (temporary reactions) – and also in tPALEO-families-1 to 'innovations' of their individual members, and in tPALEO-gentilities-2 to 'innovations' of their tPALEO-families-1 and their individual members, and in tPALEO-phratry-3 as a whole the reaction to 'innovations' of their tPALEO-gentilities-2, their tPALEO-families-1 and their individual members, – *that coincide with those for biological systems only (animate nature)*. The same concerns the procedures of fixation of the adapted innovations in historical ('system') memory – also by tPALEO-humans, both by tPALEO-families-1, and tPALEO-gentilities-2 (in all these cases the ratio of characteristic times is about 1 to 15,15). In absolute figures the last means that the 'commonly adapted' innovation can be preserved by the tPALEO-humans for ~15 years running. But if after the expiration of this time there is no 'reinforcement' *(in the this or that form)* of the given system memory, it will mean 'forgetting' – the elimination of the specified information from the system memory of tPALEO-phratry-3.

Within the framework of the suggested concept it is important, that the characteristic size of *accuracy* of these *implements* (and, consequently, of the accuracy of the production, made using them) coincides with the characteristic size of pluricellular organism (or actually of tPALEO-human) *cells*. Therefore, taking into account the total significance of the above-mentioned properties the considered tPALEO-phratry-3 could be called a '*Biogeocenoso-cells society*', representing the basic structure of **Proto-Humankind-3 = Meso-Humankind-0**.

Meso-Humankind-1. About 8100–8350 years ago (the calculated 'ideal' data) in separate *NEO-phratrial alliances-4* (consisting consequently of *NEO-phratries-3 – NEO-gentilities-2 – NEO-families-1 – NEO-humans*), compactly living on territories with the linear sizes up to several hundreds kilometers there started to rise ***proto-writing***.

Is not it a too early date of this event that the offered calculation suggests? It is traditionally considered that it took place approximately 2–2,5–3 thousand years later. But in the encyclopedia 'History of Mankind' in the subdivision 'The Beginnings of writing' the forewords says: 'If to consider, that "the characters" from caves with paintings of paleolith epoch are an equivalent of graphics, and not of real writing, it is possible to ascertain, that the most ancient specimens of writing are dated 11 thousand years. On five basalt stones with graphics, found in 1996 by B. Jammons and D. Stordeur in Dzherf-'el'-Akhmar in Syria, there are found the traces of polishing and pictograms in the form of zigzags, arrows and two figures – of a four-footed animal and predatory bird. This beginning of writing seems to have had no continuation. The same fortune was had the tablets from Tartaria (Romania), which entered the archaeologic set referring to the khalcolith period, at the Karanovo VI level dating the 5th millenium: the pictograms (a goat and an ear of grain) and the geometrical marks, probably, expressing the system of writing, that disappeared together with that dynamical period, to which also refer the rich burial places in Varna (Bulgaria) (Mohen 2003: 28). There is an opinion expressed, that the primitive writing appeared in Mesopotamia about 10 thousand years ago (Van Doren 1991: 10). In their turn, the Chinese and American experts identify the age of 8 thousand years for the marks scraped on tortoiseshells (Lawler 2003). So the calculated figure of 8,10–8,35 thousand years seems to be reliable.

Besides, the NEO-humans showed ability to involve in the 'orbit' of the ordinary life and activity those surrounding them objects of inanimate and/or animate nature whose sizes could be changed (corrected, rectified) with accuracy already up to several *tens of micrometers* (see Fig. 4d). It is convenient to name such objects ***instruments***, their examples – rather high-accuracy neolith toolkit and products obtained using it (and also the further essential increase by NEO-phratrial alliance-4 of quality of life).

The fact of great is that the lowered values of inertia of adaptive behaviour (temporary reactions) are typical of NEO-phratrial alliance-4 and all its constituents in comparison *with those for biological systems only (animate nature)*. The same concerns the appropriate procedures of fixation of adapted innovations in the historical ('system') memory (in all these cases the ratio of characteristic

times is about 1 to 7,68). In absolute figures the last means that the 'commonly adapted' innovation can be preserved by the NEO-humans for ~7,6 years running. But if after the expiration of this time there is no 'reinforcement' *in this or that way* of the given system memory it will mean 'forgetting' – the elimination of the specified information from the system memory of NEO-phratrial alliance-4.

Within the framework of the suggested concept it is important that the characteristic size of *accuracy* of these instruments (and, consequently, the accuracy of production made using them) coincides with the characteristic size of *cell's compartments* of pluricellular organism, or actually of NEO-humans. Therefore taking into account the total significance of the above-mentioned properties the considered NEO-phratrial alliance-4 could be named '*Biomo-cell's compartments society*', representing the basic structure of **Meso-Humankind-1**.

Meso-Humankind-2. In the 1431–1446s of our era (an average range of dates) in separate *INDU-societies-5* (consisting correspondingly of *INDU-societies-4*, *INDU-societies-3*, *INDU-societies-2*, *INDU-societies-1* and *INDU-humans*), compactly living on territories with the linear sizes up to several thousand kilometers there start to arise ***proto-technology of the information replication.***

Besides these INDU-humans showed an ability to involve in the 'orbit' of the ordinary life and activity those surrounding them objects of inanimate and/or animate nature whose sizes could be changed (corrected, rectified) with accuracy already up to several *micrometers* (see Fig. 4e). It is convenient to name such objects ***machines and mechanisms***, our environment is simply overflown with examples of this kind (providing super-essential increase of INDU-society-5 quality of life).

For INDU-society-5 the tendency proceeds to lower the typical values of inertia of adaptive behaviour (temporary reactions of all its components). The same also refers to the appropriate procedures of fixation of assimilated innovations in the historical ('system') memory (in all these cases the ratio of characteristic times is about 1:5,11). In absolute figures the last means, that the 'commonly adapted' innovation can be preserved by the INDU-humans for

~5,1 years running. But if after the expiration of this time there is not any 'reinforcement' of the given system memory *in this or that form* it will mean 'forgetting' – the elimination of the specified information from the system memory of INDU-society-5.

Within the framework of the suggested concept it is important, that the characteristic size of *accuracy* of these machines and mechanisms (and, consequently, the accuracy of production made using them) coincides with the characteristic size of *cell's sub-compartments* of pluricellular organism, or actually of INDU-human. Therefore taking into account the total significance of the above-mentioned properties the considered INDU-society-5 can be called '*Natural zones-cell's sub-compartments society*' representing the basic structure of **Meso-Humankind-2**.

Meso-Humankind-3 = Cosmo-Humankind-0. In about 1946 of our era (an average date) in separate *COMP-societies-6* (consisting correspondingly of *COMP-societies-5, COMP-societies-4, COMP-societies-3, COMP-societies-2, COMP-societies-1* and *COMP-humans*), compactly living on territories with the linear sizes up to several tens thousand kilometers (*i.e.* on the whole Earth surface!), there start to arise ***proto-technology of developing computer equipment and electronic local memory***.

And besides these COMP-humans showed ability to involve in the 'orbit' of the ordinary life and professional activity those surrounding them objects of inanimate and/or animate nature whose sizes could be changed (corrected, rectified, formed) with accuracy already up to several *hundreds nanometers* (see Fig. 4f). It is convenient to call such technologies the ***submicron*** ones.

For COMP-society-6 the tendency proceeds to lower typical values of inertia of adaptive behaviour (temporary reactions) of all its components. The same refers to the appropriate procedures of fixation of assimilated innovations in historical ('system') memory (in all these cases the ratio of characteristic times is about 1:3,89). In absolute figures the last fact means, that the 'commonly adapted' innovation can be preserved by the COMP-humans for ~3,8 years running. But if after the expiration of this date there is no 'reinforcement' *in this or that way* of the given system memory it will mean 'forgetting' – the elimination of the specified information from the system memory of COMP-society-6.

Within the framework of the offered concept it is important, that the characteristic of accuracy of these submicron technologies (and, consequently, the accuracy of production made using them) coincides with the characteristic size of '*elementons*' – *i.e.* of procaryote units or ultra structural intracellular elements. Therefore taking into account the total significance of the above-mentioned properties the considered COMP-society-6 could be named '*Biogeosphero-elementons society*' representing the basic structure of Meso-Humankind-3 (= Cosmo-Humankind-0).

Cosmo-Humankind-1. In about 1979–1980s of our era (a calculated 'ideal' data) in separate *COSM1-societies-7* (consisting of representatives of hierarchy *COSM1-societies-6, COSM1-societies-5, COSM1-societies-4, COSM1-societies-3, COSM1-societies-2, COSM1-societies-1* and *COSM1-humans*: today – of some already mature societies, in perspective – of all societies) whose interests expanded to the spaces with linear sizes up to several hundreds megameters (*i. e.* comparable to the diameter of the Moon orbit!) there started to rise the ***proto-technology of developing network technique and distributable-coherent electronic memory.***

And in addition these COSM1-humans showed an ability to involve in the 'orbit' of the ordinary life and professional activity those surrounding them objects of inanimate and/or animate nature whose sizes could be changed (corrected, rectified, formed) with accuracy already up to several *tens nanometers* (see Fig. 4g). Lack a better term we shall name them the ***technologies of 'tens nanometers'***.

For COSM1-society-7 the tendency proceeds to lower typical values of inertia of adaptive behaviour (temporary reactions) of all its components. The same refers to the appropriate procedures of fixation of assimilated innovations in the historical ('system') memory (in all these cases the ratio of characteristic times is about 1:3,21). In absolute figures the last fact means, that the 'commonly adapted' innovation can be preserved by COSM1-humans for ~3,2 years running. But if after the expiration of this term there is no 'reinforcement' *in this or that way* of the given system memory it will mean 'forgetting' – the elimination of the specified information from system memory of COSM1-society-7.

Within the framework of the sugested concept it is important, that the characteristic accuracy of these technologies of *'tens na-*

nometers' (and, consequently, the accuracy of production made usind them) coincides with the characteristic size of macromolecular structures. Therefore taking into account the total importance of the above-mentioned properties the considered COSM1-society-7 could be called a '*Nearplanet-macromolecular society*', representing the basic structure of **Cosmo-Humankind-1**

Cosmo-Humankind-2. In approximately 1981–1982 of our era (a calculated 'ideal' data) in separate *COSM2-societies-8* (consisting of representatives of hierarchy of *COSM2-societies*-7, *COSM2-societies*-6, *COSM2-societies*-5, *COSM2-societies*-4, *COSM2-societies*-3, *COSM2-societies*-2, *COSM2-societies*-1 and *COSM2-humans*: today – of some already mature societies, in perspective – of all societies) whose interests distributed to the spaces around the Earth with the linear sizes up to several gigameters (even if they did not realize this fact as such) there started to arise the ***proto-technology of developing nanoapparatus and distributable-independent electronic memory.***

And in addition these COSM2-humans showed an ability to involve in the 'orbit' of the ordinary life and professional activity those surrounding them objects of inanimate and/or animate nature whose sizes could be changed (corrected, rectified, formed) with accuracy already up to a *nanometer* (see Fig. 4h). Such ***nanotechnologies*** are known well enough recently.

For COSM2-society-8 the tendency proceeds to lower typical valuess of inertia of adaptive behaviour (temporary reactions) of all its components. The same refers the appropriate procedures of fixation the assimilated innovations in historical ('system') memory (in all these cases the ratio of characteristic times is about 1:2,77). In absolute figures the last means that the 'commonly adapted' innovation can be preserved by COSM2-humans for ~2,8 years running. But if after the expiration of this term there is no 'reinforcement' *in this or that way* of the given system memory it will mean 'forgetting' – the elimination of the specified information from the system memory of COSM2-society-8.

Within the framework of the suggested concept it is important, that the characteristic of *accuracy* of these *nanotechnologies* (and, consequently, the accuracy of production made using them) coincides with the characteristic size of organic molecules.

Therefore taking into account the total importance of the above-mentioned properties the considered COSM2-society-8 could be called an '*Intermediate Space-organic molecules society*' representing the basic structure of **Cosmo-Humankind-2**.

And so on. It is possible to continue this analysis long enough. In particular, one can mention a number of such important aspects of Humankind social-technological meta-evolution, as the following:

- synthesis of the set of the basic structures of Cosmo-, Star and others meta-phases of Humankind's meta-evolution to the extent of Post-Meta-Galaxy;
- revealing the laws of growth and attenuation dynamics of each of meta-phases (*e. g.*, the tPALEO-society has obviously passed the peak of its development and is represented now only in several detached specimens – the NEO-society is on wane, but still plays a noticeable role in the Humankind structure – the INDU-society is near to the peak of its development or has just passed this peak– the COMP-society is developing impetuously encompassing a larger part of the Humankind, etc.), but there remains the problem of associating these local curves of development to the absolute time scale;
- detailed and comprehensive substantiation of the fundamental (for the suggested conception) interpretation of all calculated results as *ideal*, specifying only their control points, introducing the quantitative 'framework' both in the hierarchical system of ature, and in the process of its historical development;
- the question of distinction of the forms of aiming in social-technological hierarchy from those in hierarchies of the inanimate and animate;
- the comparative analysis of properties and features of adaptive behaviour of the tPALEO-humans, NEO-humans, INDU-humans, COMP-humans, COSM1-humans, COSM2-humans, etc. – of the basic 'units' of societies, which arise consistently in the course of meta-evolution, but then exist in parallel, often 'side by side' …;
- the tendencies of demographic dynamics (previously in [Grinchenko 2002]; as the first step of the given research we suggest a mathematical formula allowing calculating total

growth of population plus the growth of computer-network hardware means in the course of social-technological meta-evolution;

– the question of the plurality of 'habitable' Worlds, the answer to which, nevertheless, seems quite obvious, as within the framework of the suggested concept there were not introduced any special assumptions proving the emergence of the occurrence of Humankind by some concrete realities of the Earth; etc.

But the scope of article is extremely limited. So I intend to examine all these problems in detail in the planned subsequent publications. Here I shall limit to summarizing some results of the analysis carried out in section 4 in Table 3.

Table 3. Social-technological meta-evolution of Humankind (history and forecast)

№	Meta-phase of Human-kind	Beginning (calculated)	Informational 'prime mover-factor'	Calculated sizes of activity sphere (max/min), toolkit
1	2	3	4	5
1	Before-1 (troops)	~28.5 million year ago	before-social communications	64 m/28 sm, before-rigs
2	Proto-1 (bPALEO)	~1,9 million year ago	social proto-memory	970m/l,8sm. proto-equipment
3	Proto-2 (bPALEO)	~125 thousand year ago	proto-speech/proto-language	15 km/1,2 mm, implements
4	Meso-1 (NEO)	~8,2 thousand year ago	proto-writing	222 km/80 microns, instruments
5	Meso-2 (INDU)	~1440 year A.D.	proto-technology of the information replicating	3370 km/ microns, machines and mechanisms
6	Meso-3 (COMP)	~1946 year A.D.	proto-technology of developing computer equipment and electronic local memory	51 mm/350 nanometers, submicron technologies

Table continued

1	2	3	4	5
7	Cosmo-1	~1980 year A.D.	proto-technology of developing network technique and	770 mm/23 nanometers, technolo-

			distributable-coherent electronic memory	gies of 'tens nanometers'
8	Cosmo-2	~1982 year A.D.	proto-technology of developing nanotechnique and distributable-independent electronic memory	1 1,7 gm/1,5 nanometers, nanotech-nologies
9	Cosmo-3	— „ —	proto-subnanotechnology ?	1,18 astron.unit (au.)/0,l nm(l A)
10	Stars-1	— „ —	proto-picotechnology ?	18 au/6,6 picometers
11	Stars-2	— „ —	proto-subpicotechnology ?	270 au/0,43 picometers
12	Stars-3	— „ —	etc. ?	4130 au/0,29 10^{-11} sm
13	Stars associations- 1	— „ —	etc. ?	1 light-year (l.e.)/0,19 10^{-12}sm
14	Stars associations-2	— „ —	etc.?	15 l.e./0,12 10^{-13}sm
15	Stars associations-3	— ,. —	etc. ?	227 l.e./0,82 10^{-16}sm
16	Galactic-1	— „ —	etc. ?	3,4thous. l.e./0,54 10^{-16}sm
17	Galactic-2	— „ —	etc. ?	52,2 thous.l.e./0,36 10^{-17}sm
18	Galactic-3	— „ —	etc. ?	790 thous. l.e./0,24 10^{-18}sm
19	Supercongestions of galaxies-1	"	etc. ?	12 mill.l.e./0,16 10^{-19}sm
20	Supercongestions of galaxies-2	"	etc.?	182 mill. l.e./0,10 10^{-20}sm
21	Supercongestions of galaxies-3		etc. ?	2,75 bill. l.e./0,68 10^{-22}sm
22	Post-Meta-Galaxy-1	— „ —	etc. ?	42 bill. l.e./0,45 10^{-23} sm

5. COMPARATIVE ANALYSIS OF INANIMATE, ANIMATEAND SOCIAL-TECHNOLOGICAL META-EVOLUTION FEATURES

The presented analysis allows to put forward the assumption, that the process of the Universe development on the whole seems **programmed** (or, if you wish, **purposeful**) (Grinchenko 2004d). And in the informatics-cybernetic terms this program/purpose can be formulated as follows: 'Permanent – continuous and by means of relatively discrete transitions (from the inanimate to the animate and further to the social-technological) – formation of "itself" as a complete system of hierarchical search optimization (realizing adaptive behaviour of own components) aiming at permanent maximization of its efficiency'. The ranging spectrum of possible consequences (including those of the epistemological character) of this assumption itself seems quite obvious to the reader.

In fact, for a single representative of *the inanimate nature as a whole* the hierarchical system of search optimization represents a connected only in pairs (by the ascending activity and descending influence of target criteria) hierarchical set of *pseudo-contours* (in the structure of pairs of forming them tiers) – the least effective among the possible structures of optimization contours. It determines the small efficiency of optimization and of the system on the whole – of a 'vertical' one(where any parallel structures are absent), limited from above only by the current temporary characteristics of the Universe.

In its turn, for each representatives of *animate nature as a whole* (in each possible zones of their existence) the hierarchical system of search optimization represents a hierarchical set *of contours of permanently increasing level of complexity* (in the structure of tetrads of tiers, forming them) additionally interlocked by 'vertical' multilevel communications (*system memory*)– which are much more effective in comparison with pseudo-contours. It determines a higher efficiency of optimization of every such a representative of the animate system on the whole – of a 'vertical-horizontal' one (where simultaneously there function up to 13 parallel structures of different 'height' in hierarchy). But the last themselves, being limited in their size by the size of small planets groups (because of the excess by the characteristic time of corresponding processes of the time of the Universe existence), can not solve the problem of formation of effective optimization system, *homolographic* to the Universe.

This fact seems to be an incentive motive of the emergence of systems of '*human-artificial*' nature in the Universe. The similar systems of search optimization – are 'vertical-horizontal' ones (where there can function simultaneously up to 22 parallel structures of different 'height' in hierarchy) and unlimited from above by current temporary characteristics of the Universe. The constituting them 'vertical' structures represent rather complex hierarchical contours, which can contain (in potency) up to 23 tiers, forming them (*superior to an individual*).

But the most characteristic difference *of each social-technological* hierarchies of the kind from the hierarchy *alive* is the presence of the *beyond individual* **symmetric** (relative to this individual) and **reflecting** (in relation to the upper tiers of hierarchy) '**antitiers**' (that are not, strictly speaking, hierarchical tiers in the search-optimization sense, but only reflect the sequence of similar tiers in the animate hierarchy), thus determining the degree of human penetration 'deep into' the Universe. It seems to form – by virtue of the mentioned symmetry – *a fundamental pair of opposite, but closely interconnected tendencies of Humankind expansion both 'deep into', and 'beyond' the Universe*.

But what is the logic of *succession* of all three Nature realms? And does it really exist? From the positions of the suggested concept – the answer is apparently 'yes'. Moreover, it is possible to offer the following scenario of its realization:

1) the initial position: in the inanimate nature of 'today' (*i.e*. in the period num. 52 of in the animate meta-evolution, which began about 11 bill. years ago and will finish in ~28,3 bill. years) the highest pseudo-tier of hierarchy, which demonstrates to a complete degree its adaptive properties and consequently is effective in the hierarchy, is that of the '**Planets**'. In the inanimate hierarchy higher there starts the zone of inefficiency (for today!).

2) an intermediate position: an *animate* nature, having already started its development during the above-mentioned period num. 52 and having generated some quite effective hierarchical system of optimization of the animate, 'for *its* today' (*i.e*. in the *animate* meta-evolution period num. 13, which began about 570 million years ago and will finish in ~440 million years), has started the formation of the successive (higher in the hierarchy) effective tiers of a hierarchical contour '**Biogeosphere**' – the differentiation of '**Planets**' pseudo-tier. That is of the *last* of the effective (for the

current period № 52) tiers in the inanimate hierarchy: in the animate meta-evolution the dead end is to come (already in some 440 million years) – the zone of inefficiency of the inanimate! As obviously it is impossible to form anything effective on an inefficient 'foundation'…

3) the resulting position: it is just for this reason, at the given 13th period of animate meta-evolution (hardly reaching the above-stated dead end!) there start a '*human-artificial*' (*social-technological*) meta-evolution, which does not depend on natural restrictions of *temporary* character. As it imposes the characteristic time rates of adaptive behaviour (ranging from several hours to several years) on the hierarchical systems formed, irrespective to the size of developing spaces (in the perspective, maybe, up to the borders of the Universe). From this point of view it is possible, if necessary, to introduce the notion of the 'reason' of the emergence of social-technological meta-evolution (of the humankind and similar formations) and to prove the legitimacy of the last.

Thus, the concept of hierarchical search optimization serving as means of cardinal expansion of the thesaurus necessary for understanding the system essence of the Universe, can be used for developing constructive and effective recommendations for the Human to influence 'natural' processes of forming the originated and developing meta-systems of the Humankind.

In conclusion I shall sum up the basic aspects of the carried analysis (Table 4):

Table 4. Inanimate, animate and social-technological meta-evolution

	Inanimate	Animate	Social-technological
1	2	3	4
Initial tier and direction of meta-evolution (in hierarchy)	'plankteons'; 'upwards'	'elementons', *i.e.* ' 4 *pseudo-tiers*' lower than the best effective pseudo-tier in *inanimate* hierarchy at the moment of *animate* meta-evolution beginning; 'upwards'	organs (vertebrata cephalization), *i.e.* 4 *tiers* lower than the best effective tier in animate hierarchy at the moment of *soc.-tech.* meta-evolution; symmetrically 'upwards' and 'downwards' (functionally different)
Character of formed struc-	'vertical', limited (by tempo-	'vertical-horizontal', lim-	'vertical-horizontal', unlimited (by temporary

ture:	rary character-istics)	ited (by temporary characteristics)	characteristics)

Table continued

1	2	3	4
Complexity of structure of the basic composing element (hierarchical contour of optimization - HCO):	minimal and constant (contains always 2 hierarchical tiers)	average and increased (can contain from 2 up to 4 hierarchical tiers)	maximal and increased (can contain up to 23 hierarchical tiers)
Complexity of hierarchical system as a whole:	minimal, accrues in result overbuilding of above HCO in hierarchy	average, accrues in result a) overbuilding and sophistication of above HCO in hierarchy; b) emergence and sophistication of system memory	maximal, accrues in result a) sophistication of unique HCO in system hierarchy, that is accompanied by increase of mirror system of "antitiers": b) emergence and sophistication of system memory
Tempo of meta-evolution:	decelerated	equable	accelerated
Efficiency of optimization:	minimal	average	maximal
Stability:	maximal	average	minimal

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Appendix

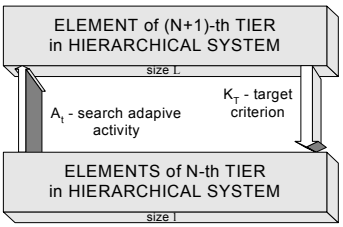


Fig. 1a. Elementary (ultimate degenerated) the diagram of the hierarchical search optimization mechanism.

The general notes: a) arrows directed upwards, have structure (reflect the relation) «many - to one», directed downwards - «one - to many»; b) A_t, S, P, R - search adaptive activities; K_T, Q, G, H - target criteria of search optimization; M - (system) memory.

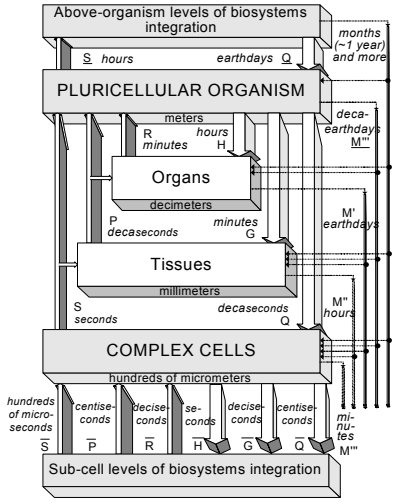


Fig. 1b. The simplified diagram of a fragment of the hierarchical adaptive search optimization mechanism of an alive nature.

Fig. 1b. A reductive diagram of a fragment of hierarchy adaptive search optimisation of the animate nature

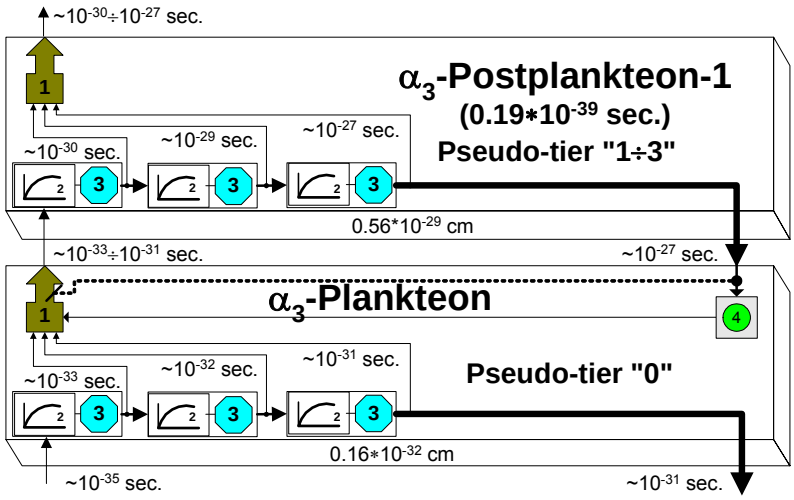


Fig. 2a. Primary hierarchical system of the inanimate optimization.

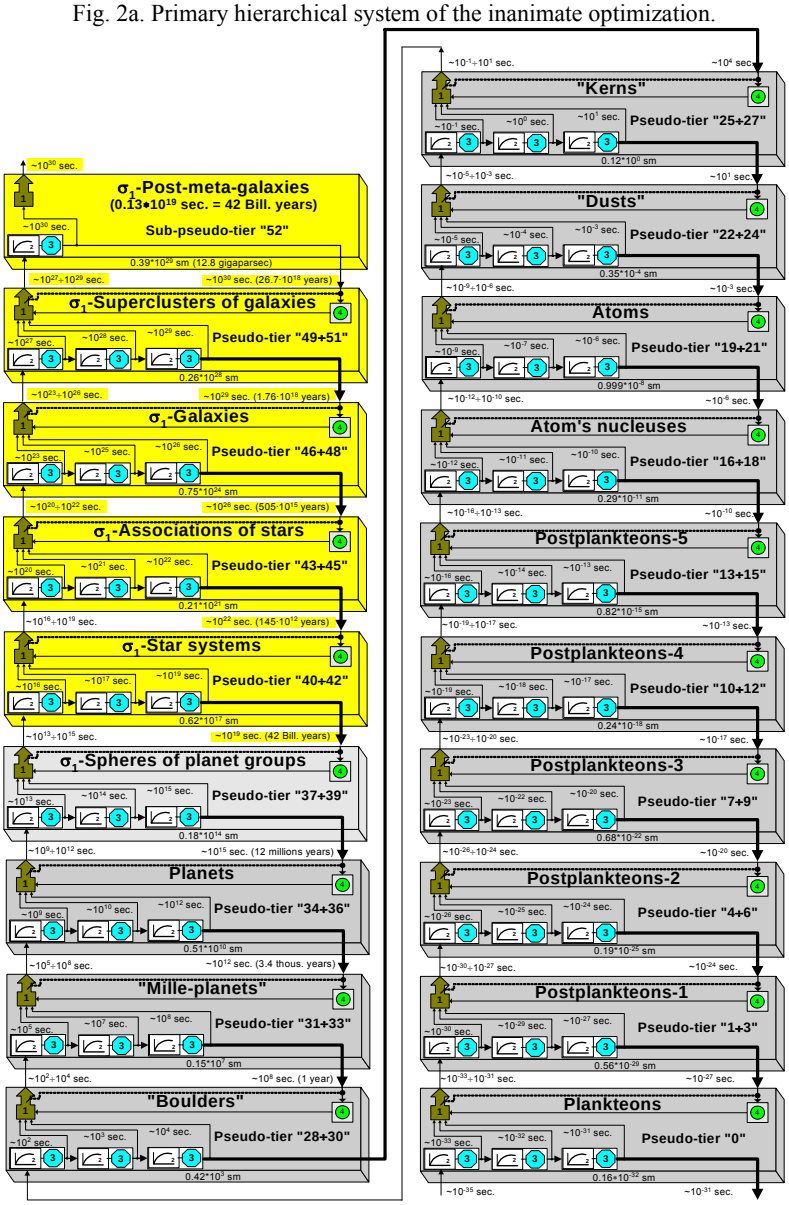


Fig. 2b. The current hierarchical system of the inanimate optimization.

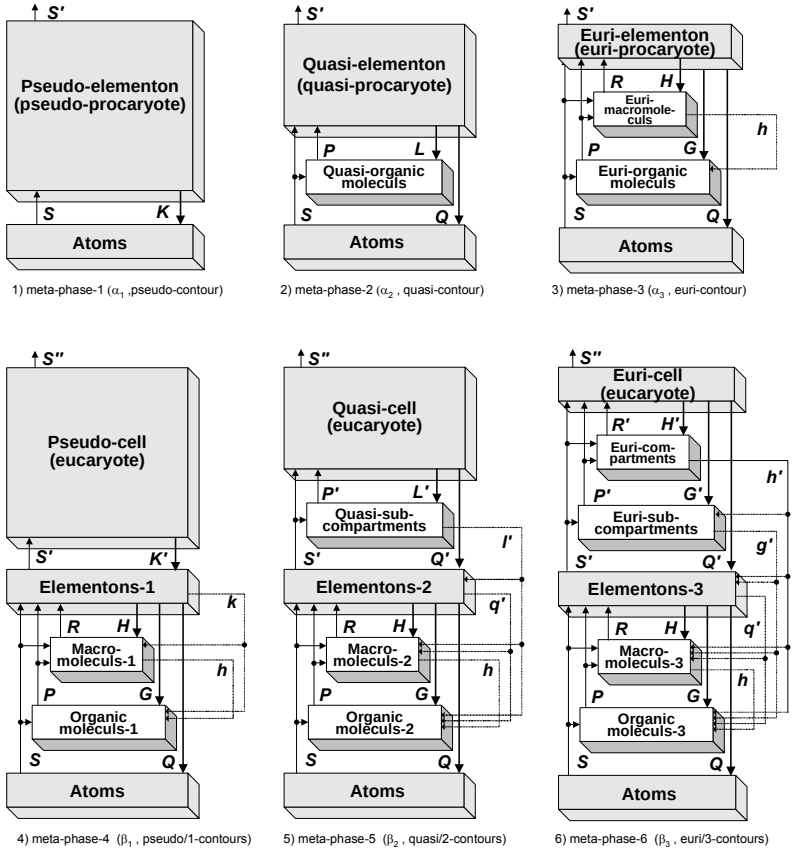
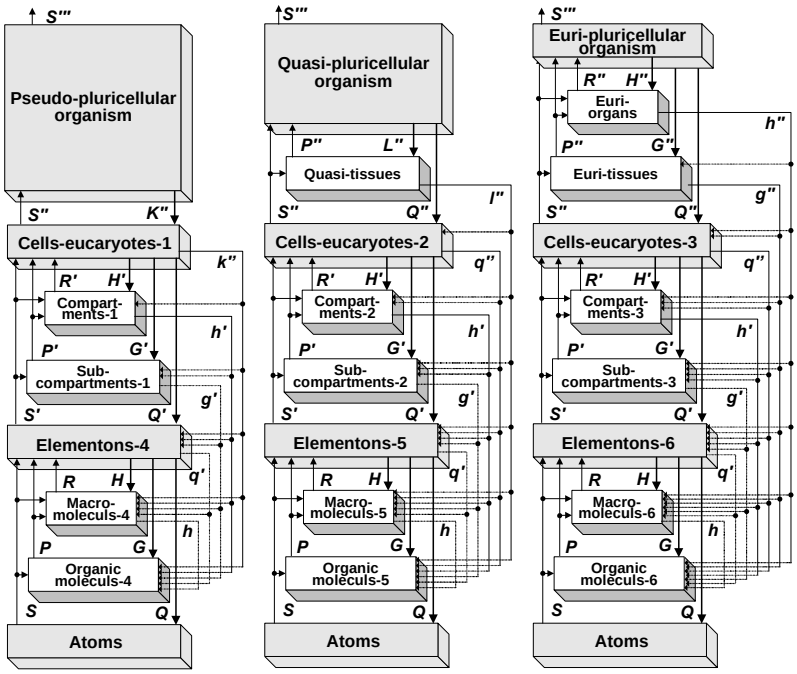
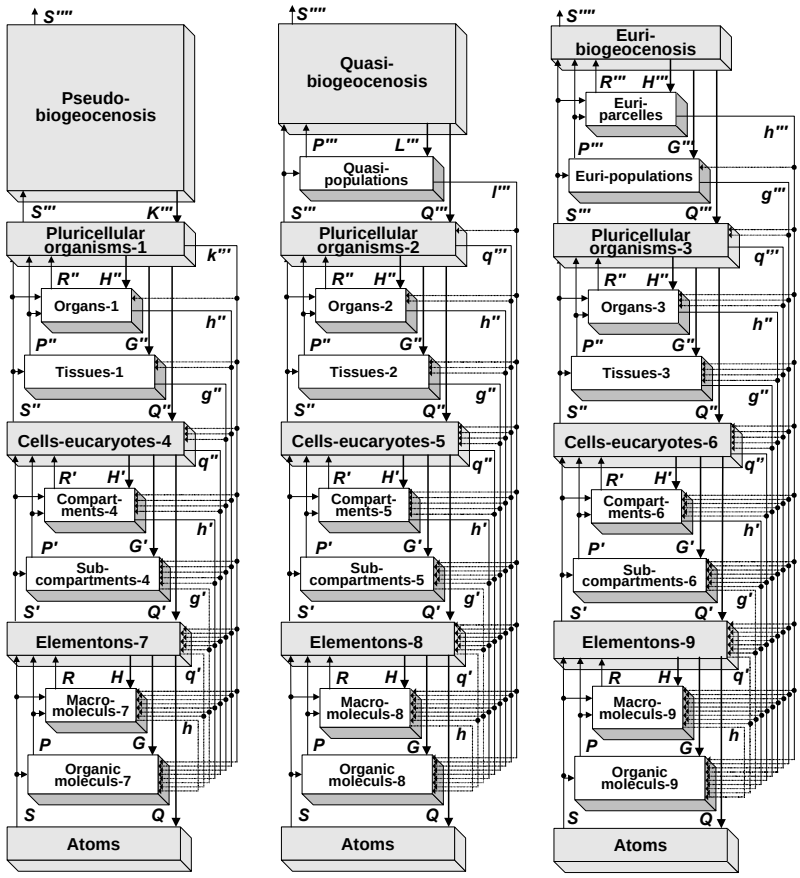


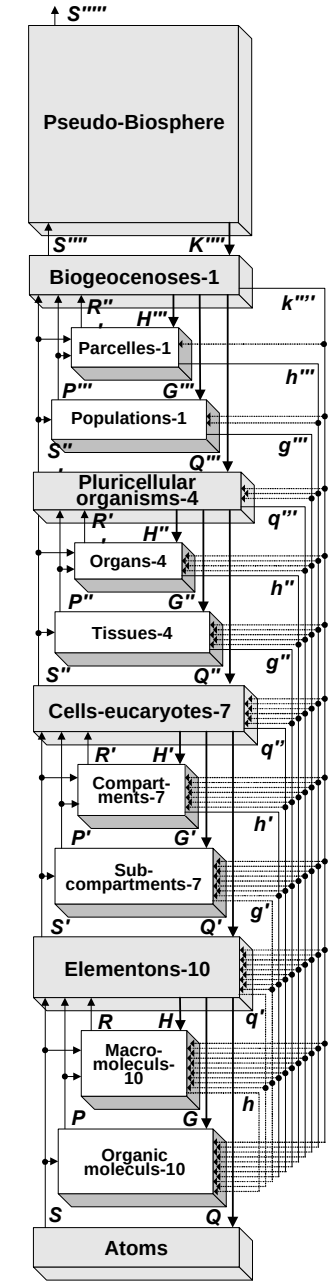
Fig. 3 (1-13). Meta-phases of alive -evolution:



7) meta-phase-7 (γ_1 , pseudo/1/4-contours) 8) meta-phase-8 (γ_2 , quasi/2/5-contours) 9) meta-phase-9 (γ_3 , euri/3/6-contours)



10) meta-phase-10 (δ_1 , pseudo/1/4/7-contours) 11) meta-phase-11 (δ_2 , quasi/2/5/8-contours) 12) meta-phase-12 (δ_3 , euri/3/6/9-contours)



13) meta-phase-13 (ε_1, pseudo/1/4/7/10-contours)

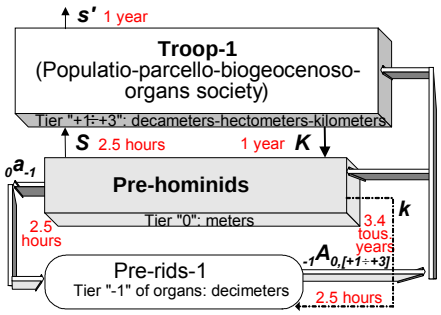


Fig. 4a. Basic structure of Before-Humankind-1 (calculated time of emergence ~28,5 million years back troops-1 of before-hominids, or typical «Populatio-parcello-biogeocenoso-organs societies».

THE NOTE to figures 4a-4з: the descending volumetric arrows here show activity of the individuals and their groups, which is expedient for treating as «labour activity on creation of the appropriate toolkit»; ascending - processes of application of this toolkit and involving of their results in «body» of hierarchical system of Humankind.

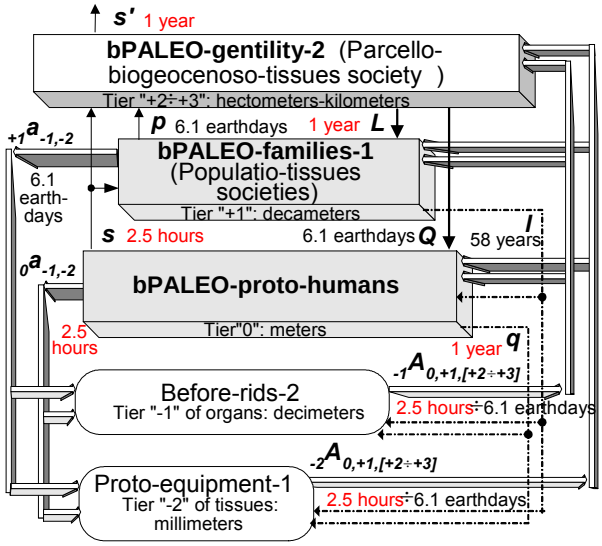


Fig. 4b. Basic structure of Proto-Humankind-2 (calculated time of emergence ~1,9 million years back): bPALEO-gentities-2 of bPALEO-proto-humans, or typical «Parcello-biogeocenoso-tissues societies».

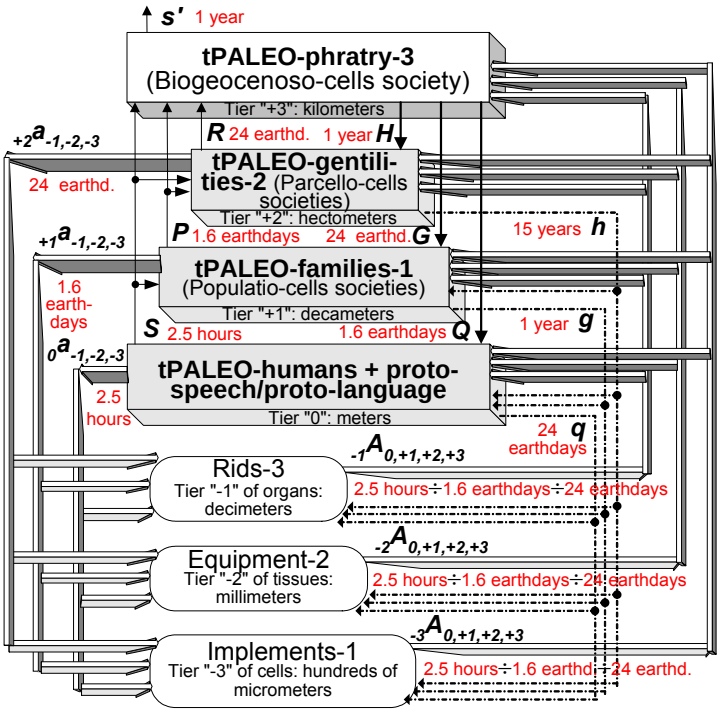


Fig. 4c. Basic structure of Proto-Humankind-3 (=Meso-Humankind-0) (calculated time of emergence ~125 thousand years back): tPALEO-phratries-3 of tPALEO-humans, or typical «Biogeocenoso-cells societies».

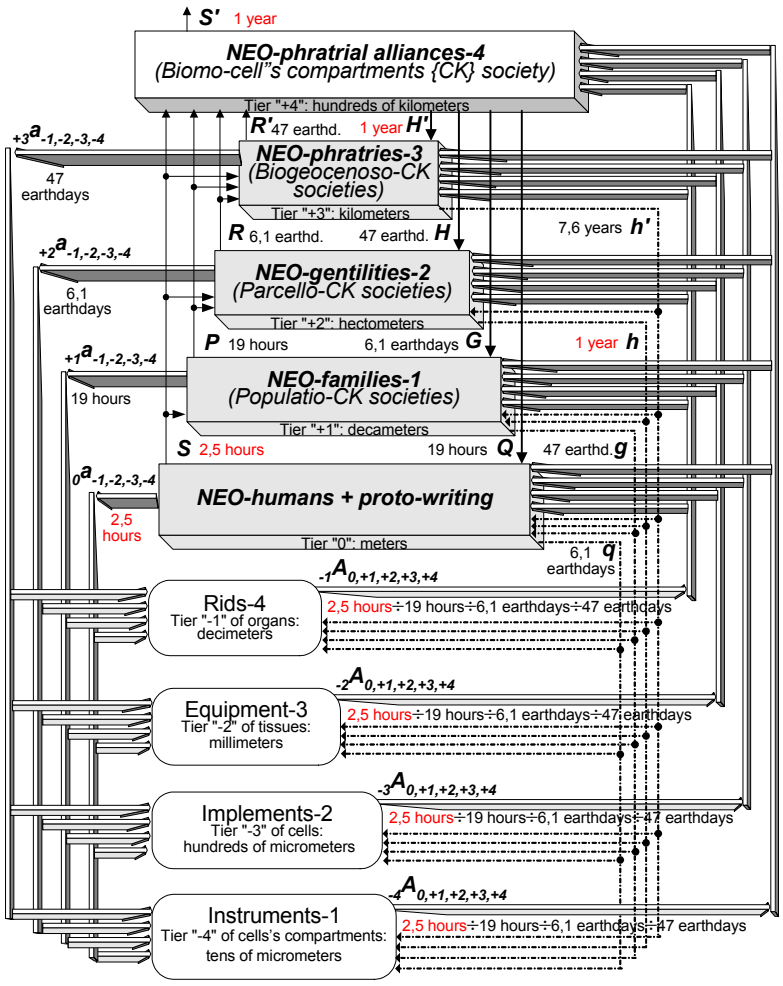


Fig. 4d. Basic structure of Meso-Humankind-1 (calculated time of emergence ~8,2 thousand years back): NEO-phratrial alliances-4, or typical «Biomo-cell"s compartments societies».

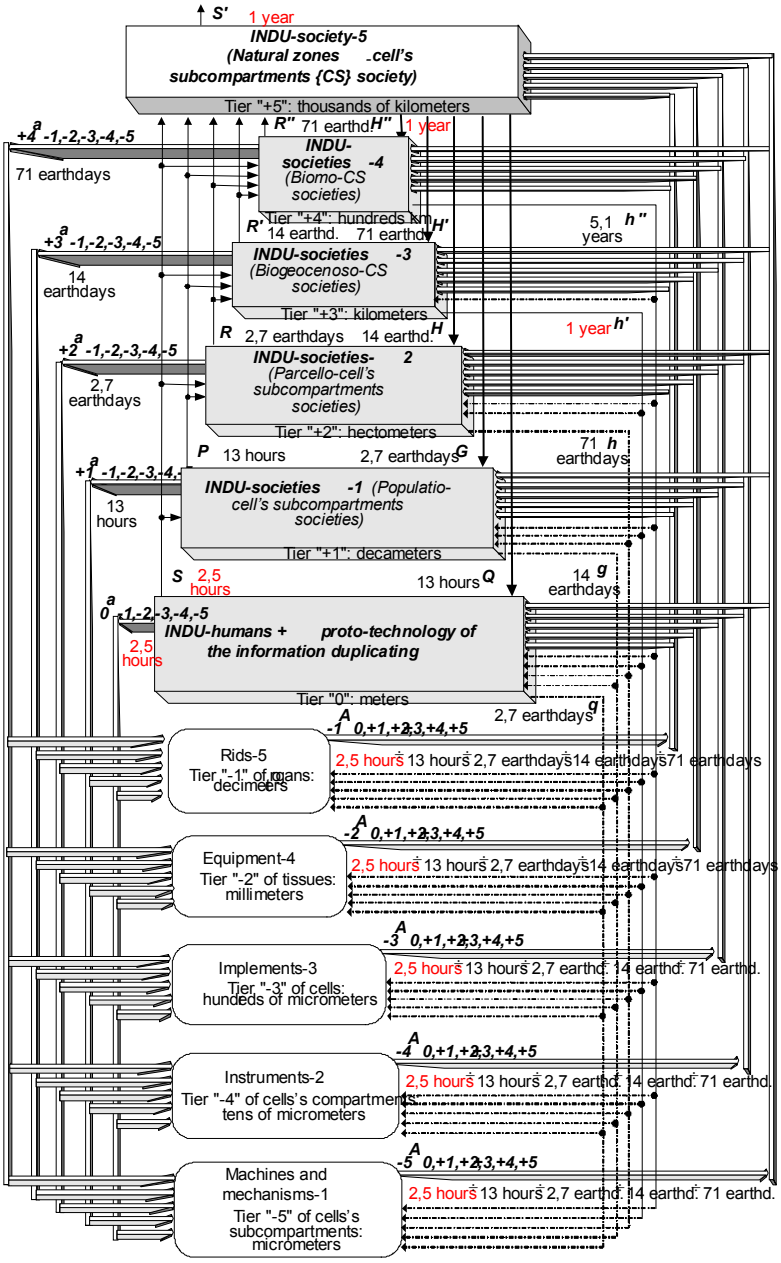


Fig. 4e. Basic structure of Meso-Humankind-2 (calculated time of emergence ~1440 A.D.):
INDU-societies, or typical «Natural zones-cell"s subcompartments societies».

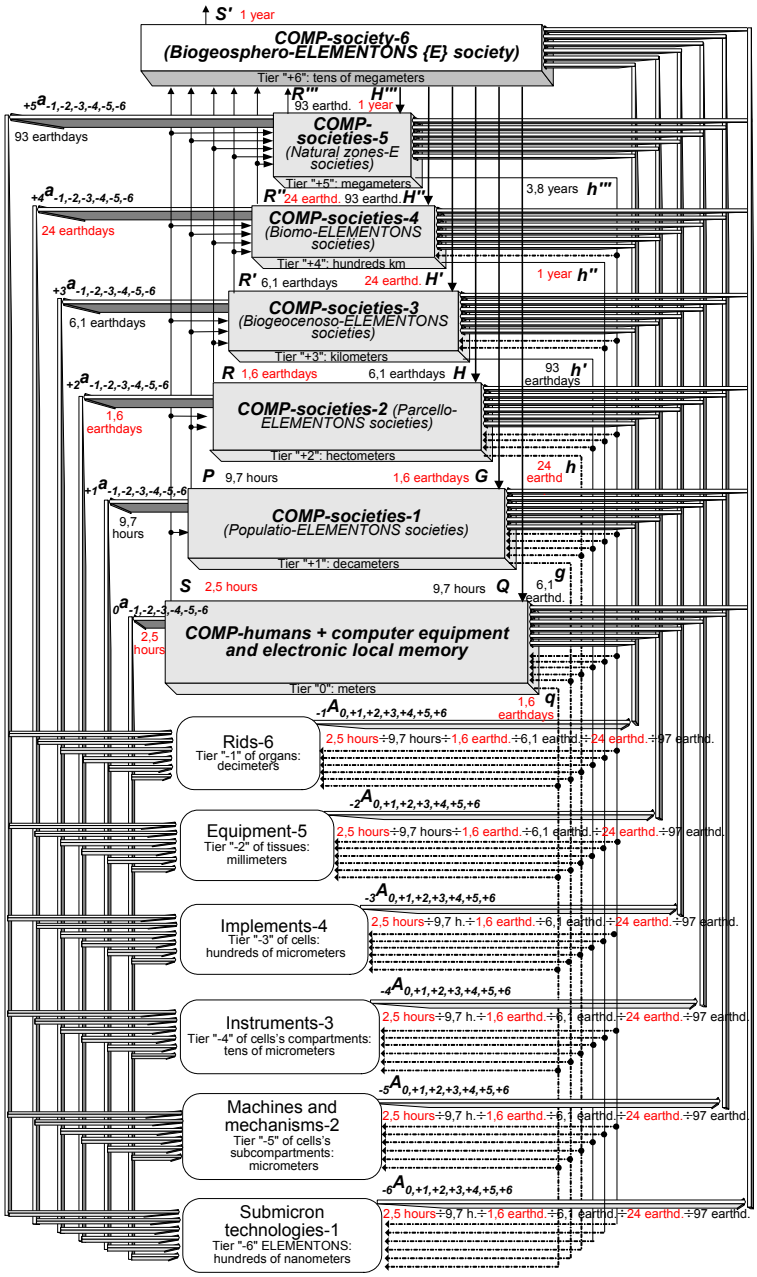


Fig. 4f. Basic structure of Meso-Humankind-3 (=Cosmo-Humankind-0 (calculated time of emergence ~1946 A.D.): COMP-societies-6, or typical «Biogeosphero-ELEMENTONS societies».

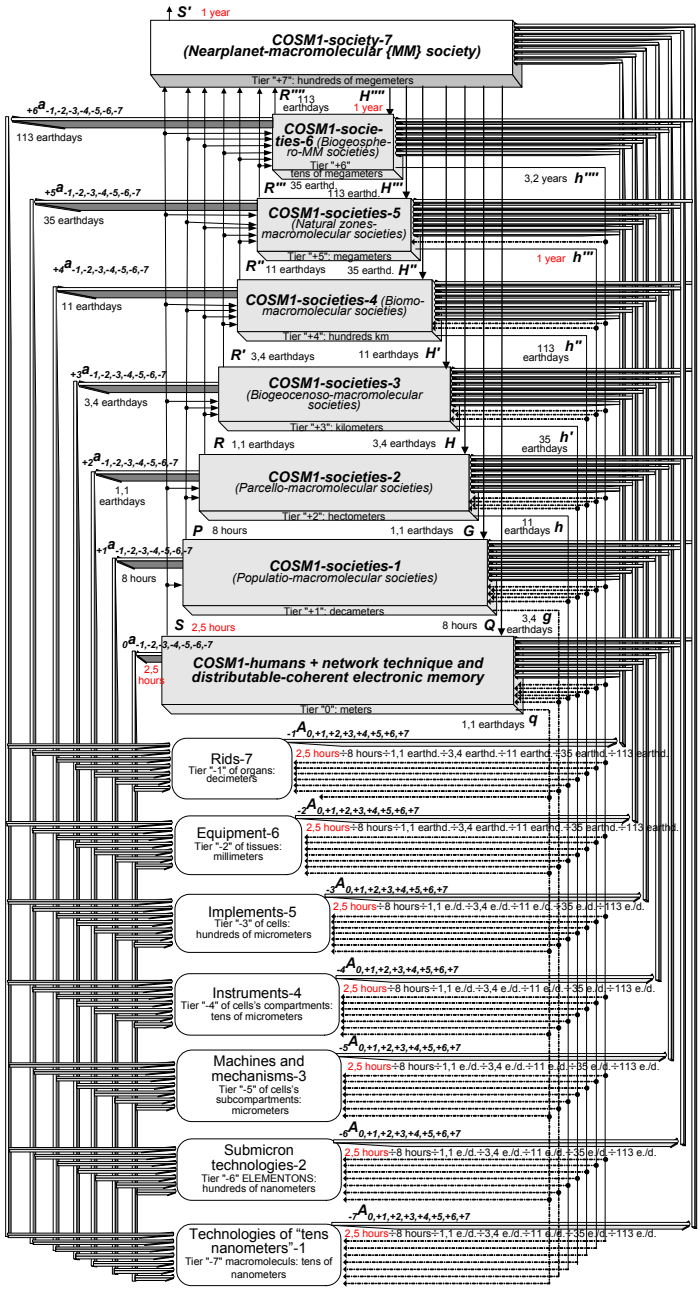


Fig. 4g. Basic structure of Cosmo-Humankind-1 (calculated time of emergence ~1982 A.D.): COMP1-societies-7, or typical «Nearplanet-macromoleculs societies».

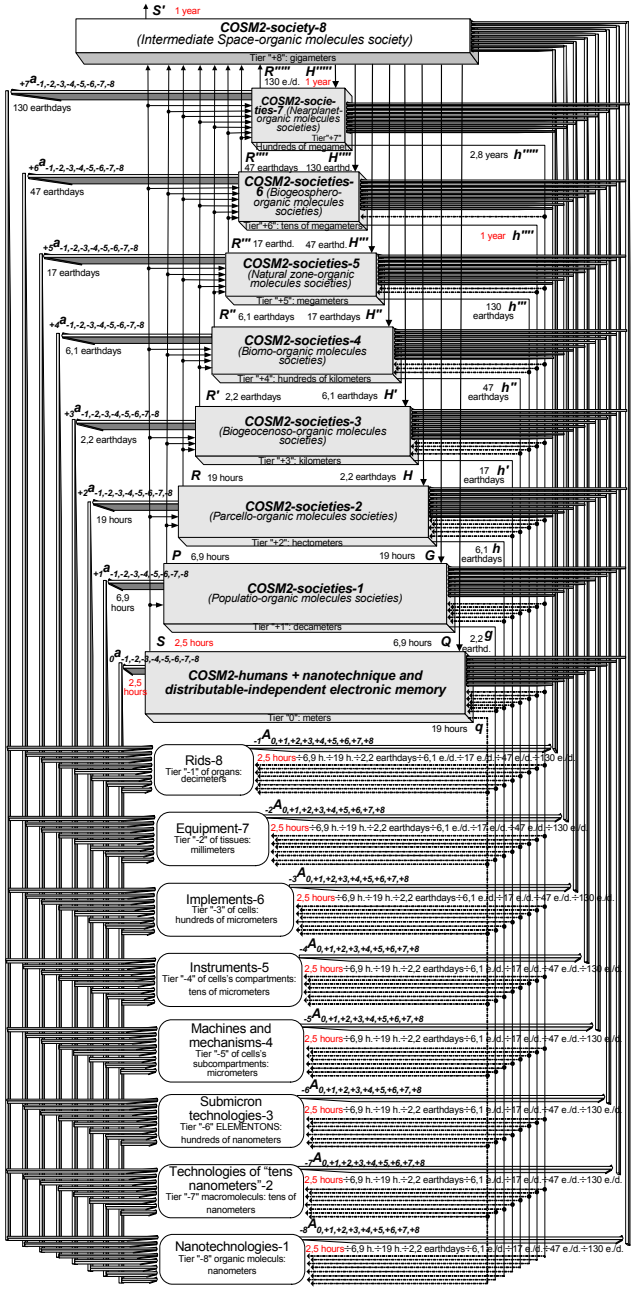


Fig. 4h. Basic structure of Cosmo-Humankind-2 (calculated time of emergence ~1982 A.D.): COMP2-societies-8, or typical «Intermediate Space-organic molecules societies».